ROOT SECRETIONS AND GROWTH OF TREE SEEDLINGS

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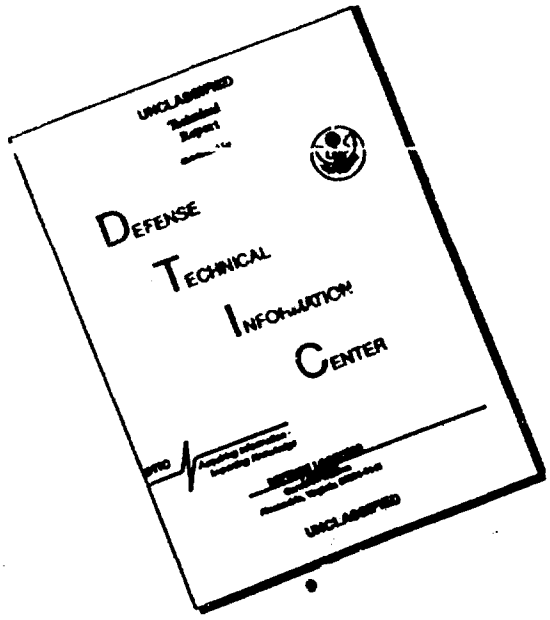

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ROOT SECRETIONS AND GROWTH OF TREE SEEDLINGS

Vestnik sel'skokhozyaystvennoy nauki
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The effect of root secretions has been studied largely with relation to herbaceous vegetation (T. I. Golomedova, F. L. Kalinin, Ye. S. Ustimenko, A. S. Okanenko and others); both negative and positive effects were pointed out.

In silviculture considerable attention is being given to this problem in cultivating mixed plantations. According to the observations of V. D. Ogiyevskiy, we find antagonism between elms and the oak, the oak and the pine, and the birch and pine. F. N. Kharitonovich pointed out the negative effect of box elder, birch, poplar and elm on the oak and Kreber and Bessler believe that the alder has a positive effect on pine. Starting with 1962 we have been studying the interaction of root secretions of oak, black locust, little-leaf elm (U. pinnato-ramosa), wild pear and apricot. Root secretions were obtained in sand and water cultures.

Methodology: A knop nutritive mixture was poured into an 18-liter glass vessel; the vessel was covered with a plywood lid with a 1.5 cm opening in which sprouted seeds of tree species were secured. In each vessel were placed 15 plants. When they had developed 3 - 4 true leaves, the cover and the plants was transferred to a new vessel with pure water every 7 days after the roots had been carefully washed. After 7 days in this vessel the cover was moved back to the original vessel and the liquid with the accumulated root secretions from the second vessel was used to treat trees planted in growing pots with soil. For sand cultures we used Mitcherlich vessels with treated river sand. In each of these we placed 10 one-year-old plants. In order to obtain root secretions the vessels were rinsed with 10 liters of water and then for 7 days they were wet with pure water, again rinsed and these rinse waters used to water plants in growing pots with soil.

TABLE 1

PLAN FOR WATERING TREES WITH ROOT SECRETIONS OBTAINED IN WATER AND SAND CULTURES

Tree species from which root secretion obtained	Tree species in growing pots				
	Summer oak	Little-leaf elm	Black locust	Wild pear	Apricot
Water culture					
Summer oak	+	-	+	-	+
Little-leaf elm	+	-	+	-	+
Black locust	+	-	+	-	+
Wild pear	+	-	+	-	+
Apricot	+	+	+	+	
Sand culture					
Summer oak	-	+	-	+	-
Little-leaf elm	-	+	-	+	-
Black locust	-	+	-	+	-
Wild pear	-	+	-	+	-

Note: + means that pots were watered with water with root secretions;
- pots were not watered.

Careful preliminary washing of the roots in the water culture and of the sand in the sand culture · carried out in order to prevent the transfer of mineral and organic substances into the rinse water and produce solutions with root secretions typical of a given plant. The effect of the root secretions obtained was studied on plants growing in pots with soil. Ten seeds had been planted in each pot. The experiment was laid out in three periods, 21 pots of each variety were used. Every 10 days the seeds were checked for sprouting, seedling growth in height. At the end of the vegetative period the plants were extracted from the pots and the structure and length of the roots, the number of side branches, the presence of mycorrhiza and tubercle bacteria were studied. The following watering schedule was used (Table 1).

Results: The sprouted seeds of the oak, black locust, little-leaf elm and apricot were set out in growing pots on 15 May; watering with root secretions started on 18 May and continued every other day until 1 October. Data on the growth of the shoots and the development of the root system are given in Tables 2 and 3.

When acorns in growing pots were watered with root secretions from different varieties the oak sprouts appeared first in pots watered with root secretions from the little-leaf elm. During the first three weeks they reached a height of 15.3 cm which was almost twice that of the controls.

TABLE 2

Growth of Tree Shoots Treated with Root Secretions

	(A) Корневые выделения древесной породы	(B) Количество растений (шт.)	(C) Высота всходов через 3 недели (см)	(D) Разница в высоте по сравнению с контролем (см)	(E) Высота всходов на конец вегетации (см)	(F) Прирост у всходов за вегетацию (см)	(G) Разница в приросте по сравнению с контролем (см)
	(J) Дуб черешчатый						
(H)	Контроль (вода)	36	8,0	0	16,0	+8,0	0
(J)	Дуб черешчатый . . .	15	11,1	+3,1	16,2	+5,1	—2,9
(K)	Вяз мелколистный . .	15	15,3	+7,3	20,5	+5,2	—2,8
(L)	Акация белая	12	13,8	+5,8	19,9	+6,1	—1,9
(M)	Груша лесная	16	11,7	+3,7	17,0	+5,3	—2,7
(N)	Абрикос	15	11,2	+3,2	18,0	+6,8	—1,2
	(L) Акация белая						
(H)	Контроль (вода)	30	8,5	0	20,1	+11,6	0
(J)	Дуб черешчатый . . .	30	33,6	+25,1	37,6	+ 4,0	—7,6
(K)	Вяз мелколистный . .	30	20,9	+12,4	24,1	+ 3,2	—8,4
(L)	Акация белая	30	49,4	+40,9	52,1	+ 2,7	—8,9
(M)	Груша дикая	30	20,4	+11,9	29,1	+ 8,7	—2,9
(N)	Абрикос	30	9,5	+ 1,0	20,1	+10,6	—1,0
	(K) Вяз мелколистный						
(H)	Контроль (вода)	30	10,6	0	25,2	+14,6	0
(J)	Дуб черешчатый . . .	30	13,6	+3,0	29,6	+16,0	+1,4
(K)	Вяз мелколистный . .	30	12,1	+1,5	29,4	+17,3	+2,7
(L)	Акация белая	30	12,7	+2,1	33,2	+20,5	+5,9
(M)	Груша дикая	30	10,8	+0,2	28,0	+17,2	+2,6
(N)	Абрикос	30	13,2	+2,6	31,5	+18,3	+3,7
	(N) Абрикос						
(H)	Контроль (вода) . . .	30	—	—	41,6	—	0
(J)	Дуб черешчатый . . .	30	—	—	20,3	—	—21,3
(K)	Вяз мелколистный . .	30	—	—	30,4	—	—11,2
(L)	Акация белая	30	—	—	15,8	—	—25,8
(M)	Груша дикая	30	—	—	15,0	—	—26,6
(N)	Абрикос	30	—	—	26,8	—	—14,8

Key: A—Species furnishing root secretions
B—number of plants
C—height of shoots after 3 weeks (cm)
D—difference in height as compared with controls (cm)
E—height of shoots by end of growing period (cm)
F—increase during growing period (cm)
G—difference in increase as compared with controls (cm)
H—controls (water)
J—summer oak (var. of Q. pedunculata)
K—little-leaf elm (Ulmus pinnato-ramosa Dieck)
L—black locust (Robinia pseudoacacia)
M—wild pear (Pyrus sp.)
N—apricot (Prunus armeniaca)

TABLE 3

Growth of Root Systems of Trees Following Treatment with Root Secretions

	(A) Корневые выделения древесной породы	(B) Количество растений (шт.)	(C) Диаметр стержневого корня (см)	(D) Разница в диаметре по сравнению с контролем (см)	(E) Длина стержневого корня (см)	(F) Разница в длине по сравнению с контролем (см)	(G) Суммарная длина боковых разветвлений (см)	(H) Разница в длине по сравнению с контролем (см)	(I) Наличие: (J) микоризы	(I) Наличие: клубеньковых бактерий (количество колоний)
	(M) Дуб черешчатый									
(L)	Контроль (вода) . .	36	0,38	0	31	0	107	0	+	—
(M)	Дуб черешчатый . .	15	0,51	+0,13	29	2	94	—13	++	—
(N)	Вяз мелколистный .	15	0,42	+0,04	28	3	233	+126	++	—
(O)	Акация белая . . .	12	0,32	—0,06	22	9	110	+3	++	—
(P)	Груша лесная . . .	16	0,40	+0,02	25	6	124	+17	++	—
(Q)	Абрикос	15	0,48	+0,10	28	3	146	+39	++	—
	(O) Акация белая									
(L)	Контроль (вода) . .	30	0,19	0	15,8	0	60	0	—	104
(M)	Дуб черешчатый . .	30	0,45	+0,26	27,8	+12,0	149	+89	—	++
(N)	Вяз мелколистный .	30	0,30	+0,11	19,9	+4,1	262	+202	—	++
(O)	Акация белая . . .	30	0,56	+0,37	19,5	+3,7	90	+30	—	++
(P)	Груша лесная . . .	30	0,40	+0,21	19,4	+3,6	74	+14	—	++
(Q)	Абрикос	30	0,29	+0,10	22,5	+6,7	47	—13	—	5
	(N) Вяз мелколистный									
(L)	Контроль (вода) . .	30	0,22	0	24,9	0	216	0	—	—
(M)	Дуб черешчатый . .	30	0,26	+0,04	27,1	+2,2	306	+90	—	—
(N)	Вяз мелколистный .	30	0,23	+0,01	28,4	+3,5	291	+75	—	—
(O)	Акация белая . . .	30	0,34	+0,12	26,8	+1,9	327	+111	—	—
(P)	Груша лесная . . .	30	0,20	—0,02	25,2	+0,3	371	+155	—	—
(Q)	Абрикос	30	0,21	—0,01	33,4	+8,5	302	+86	—	—
	(R) Абрикос дикий									
(L)	Контроль (вода) . .	30	0,32	0	28,8	0	139	0	—	—
(M)	Дуб черешчатый . .	30	0,20	—0,12	21,6	—7,2	62	—77	—	—
(N)	Вяз мелколистный .	30	0,38	+0,06	32,2	+3,4	186	+47	—	—
(O)	Акация белая . . .	30	0,20	—0,12	26,2	—2,6	69	—70	—	—
(P)	Груша лесная . . .	30	0,18	—0,14	29,8	+1,0	81	—58	—	—
(Q)	Абрикос	30	0,30	—0,02	26,8	—2,0	118	—21	—	—

Key: A--species proficing root secretions * yes ** no
B--number of plants C--taproot diameter (cm)
D--difference in taproot diameter as compared with controls
E--lenght of taproot (cm)
F--difference in length as compared with controls
G--total length of side branches (cm)
H--presence of J--mycorrhiza
K--nodule bacteria L--control (water)
M--summer oak N--little-leaf elm
O--black locust P--wild pear
Q--apricot R--wild apricot

However the increment then decreased and by the end of the growing period the little oaks were almost 3cm shorter than the controls. An analysis of their root system showed that the number of roots of the second and third orders more than twice exceeded the number in the controls but the ends of the roots quickly became suberose, black and in part fell off. Roots of the oak lacked mycorrhiza while this was present in the controls (Fig. 1).

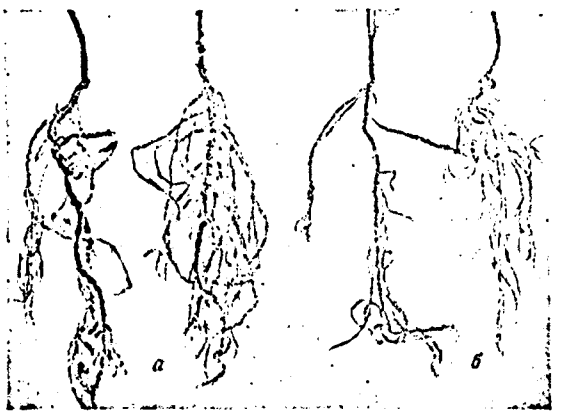

Figure 1. Root system of one-year-old seedlings of the summer oak. a--watered with root secretions of little-leaf elm; b--control (water sprinkled)

Figure 2. Root system of one-year-old seedlings of the black locust. a--watered with root secretions of the summer oak; b--control (water sprinkled)

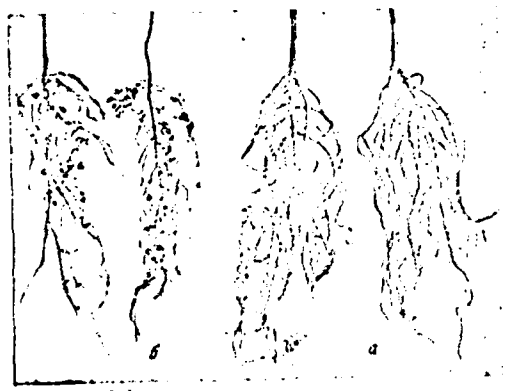

Figure 3. Root system of one-year-old seedlings of the black locust. a--watered with root secretions of the little-leaf elm; b--control (water sprinkled)

Consequently, root secretions of the elm, locust, pear, apricot and oak stimulate the sprouting of seeds and growth of shoots of the oak during the first days but then have an inhibitory effect.

Root secretions of the little-leaf elm by the end of the growing period inhibit the growth of black locust although, as in the oak, they stimulate seed germination and initial growth. On locust roots there is intensive growth of roots of the second and third orders, three times that of the controls. Seed germination and initial growth are also stimulated by root secretions from the oak and locust although in the final analysis the total increment in shoot height lags behind that of the controls. An important feature must be stressed: when locust is treated with root secretions of the oak, elm, pear and locust itself the nodule bacteria disappear from the roots while there are large numbers on the controls (Fig. 2).

Root secretions of the oak, locust, pear, apricot and elm have some stimulatory effect on seed germination and seedling growth in the little-leaf elm during the entire vegetative period.

When the apricot is treated with root secretions of the oak, locust, pear and apricot we find considerable suppression of growth in shoots and root system of young plants. Secretions of the elm, just as when applied to the oak and locust, induce growth of second- and third-order roots in the apricot but reduce its growth in height.

From what has been said we can see that root secretions of the tested varieties stimulate seed germination and initial growth of seedlings as can be readily seen in the illustrations. Then they start to inhibit growth in

the oak, locust and particularly the apricot. Root secretions eliminate the mycorrhiza from the roots of the oak and nocule bacteria from the black locust. As the number of treatments (waterings) with root secretions increases there is a reduced increase in height growth in the studied species although in total height they may surpass the control seedlings by virtue of the more intense growth during the first half of the vegetative period.